PONDS 7, 7A, AND 8 MIXING CHAMBER UPDATE

Napa Sonoma Marsh Restoration Group Meeting
December 7, 2017

MIXING CHAMBER

OVERVIEW

- Overview of History
- 2017 Monitoring and Testing
- Next Steps

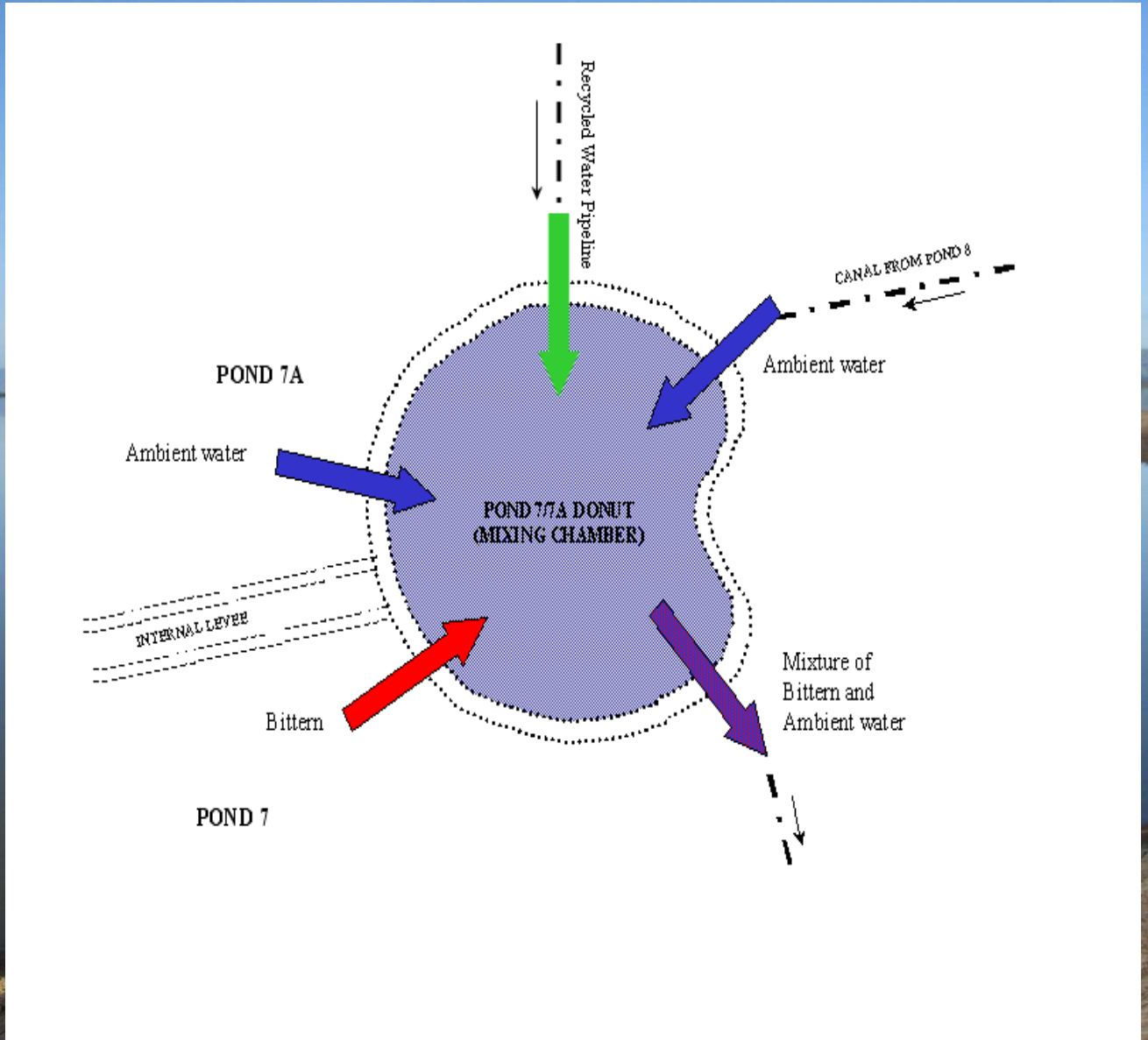
MIXING CHAMBER CONCEPT

- Purpose:
  - Completely mix high salinity bittern with ambient water (and recycled water when available)
  - Maintain constant ratio of bittern to dilution water (initially 1% by mass) throughout tidal cycle to limit bittern salinity in discharge to 3 ppt
- Proposed Process:
  - Determine flow of ambient water using flow meters
  - Use PLC to open and close Pond 7 gate to maintain flow equal to 1% by mass
  - As bittern concentration in Pond 7 declines, increase flow from Pond 7 to maintain mass ratio

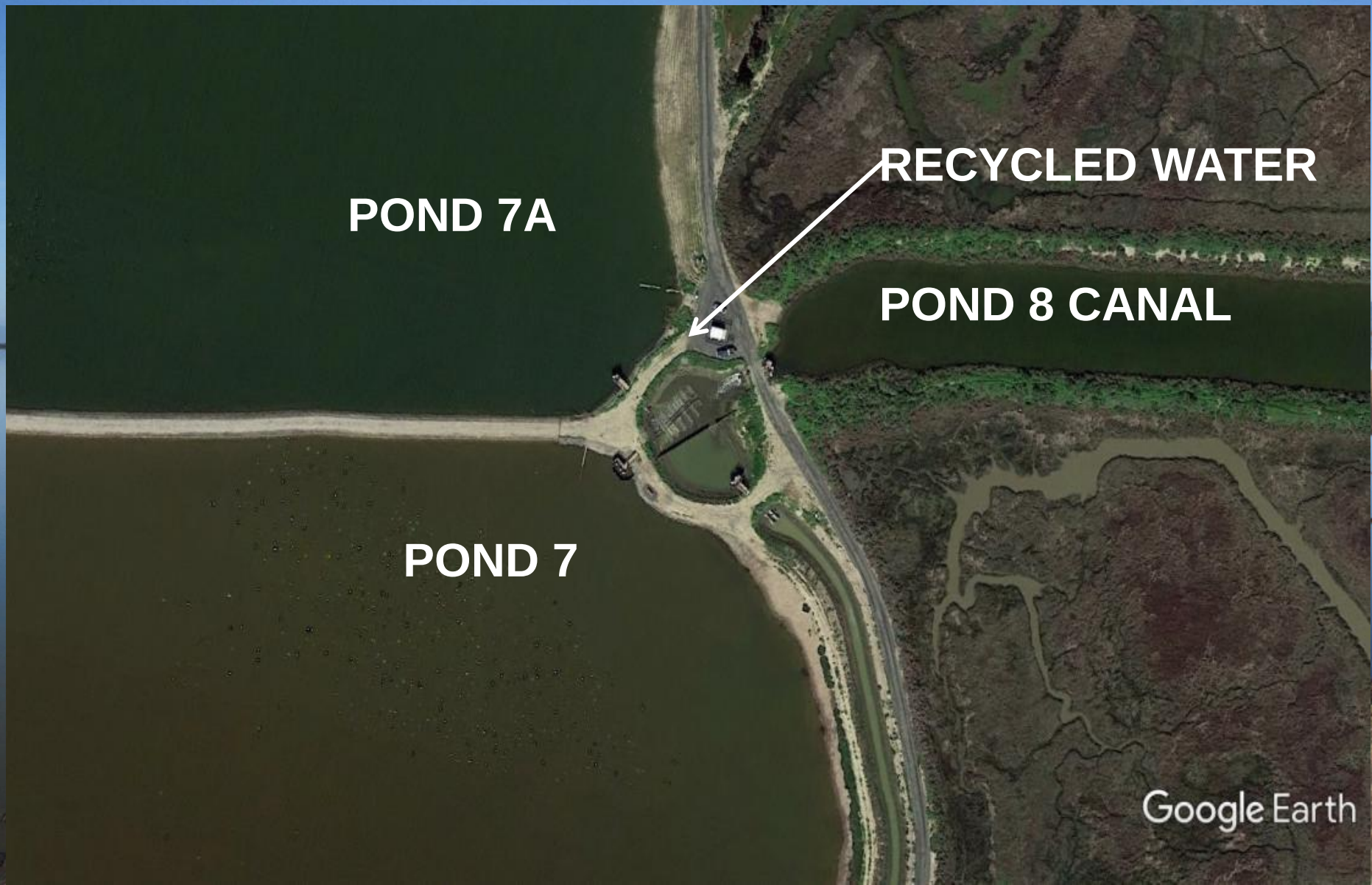
MIXING CHAMBER DESIGN ELEMENTS

- All ambient water flows and discharge are tidally-driven
- Proposed automated operation – meters monitor ambient and recycled water flows, and PLC uses algorithm to set Pond 7 gate position (as surrogate for flow)
- Air bubbler to ensure adequate mixing
- Weir (baffle) to prevent short-circuiting of bittern
- Alarms to alert remote operator
- Back-up uninterruptible power supply (UPS)
- Manual control of make-up water flow from Pond 7A to Pond 7

CONCEPTUAL LAYOUT



POST-CONSTRUCTION



POST-CONSTRUCTION

MIXING CHAMBER AT LOW WATER

(Looking Northwest toward Pond 7A)

MIXING CHAMBER OPERATING WITH BUBBLER
(Looking South toward Outlet)

CHALLENGES

- Severe Operating Conditions
- Biofouling
- Erosion and Sedimentation
- Automated System Performance
  - Actuator performance
  - Meter capability
  - Programming errors
- Pond 8 flow restriction - Pond 8 siphon appears to be “starving” Pond 8 Canal during each discharge period
- Mixing chamber is emptying less than modeled
- Higher operating water levels in Mixing Chamber reduce flow from Pond 8 and possibly Pond 7
- Air Bubbler System Performance and Operating Cost
- Remaining recycled water system control issues

BIOFOULING -- TUBEWORMS

BIOFOULING -- BRYOZOANS

BIOFOULING V3 -- ???

SEDIMENTATION IN FRONT OF POND 7 WCS

LESSONS LEARNED

- Relying on flow meters is not workable
- No funding to fix remaining problems with SCADA system
- Field calibration of most flow meters is difficult (low reliability)
- Pond water levels are variable, and hard to control
- Operating air bubbler is expensive, and system is prone to partially flooding
- **Conclusion: need to simplify operations**

2017 MONITORING AND TESTING

- **Question 1**: *is a fixed-flow discharge from Pond 7 possible (while protecting the environment)?*
- **Question 2**: *how does the mixing chamber respond to recycled water flow (what is the risk of overflow)?*
- Conducted testing in May, June, July, and August 2017
- Testing periods ranged from 4 to 12 hours, plus operability (continuous flow) testing

2017 MONITORING AND TESTING

Question 1: Monitored mixing chamber at various tide stages and with various Pond 7 flows

- Confirm SCADA flow readings with field measurements
- Confirm pond elevation readings with field measurements
- Track salinity at various locations
- Correlate salinity with tide stage/flow
- Correlate water levels in mixing chamber with tide stage
- Assess utility of bubbler


6a,b
1
7a,b
8a,b
Salinity monitoring location
Water level monitoring location
Google Ear
Imagery Date: 5/20/17


Mud Slough
0.72
mi
NS Outlet
a,b
Google Earth
Imagery Date: 5/20/17

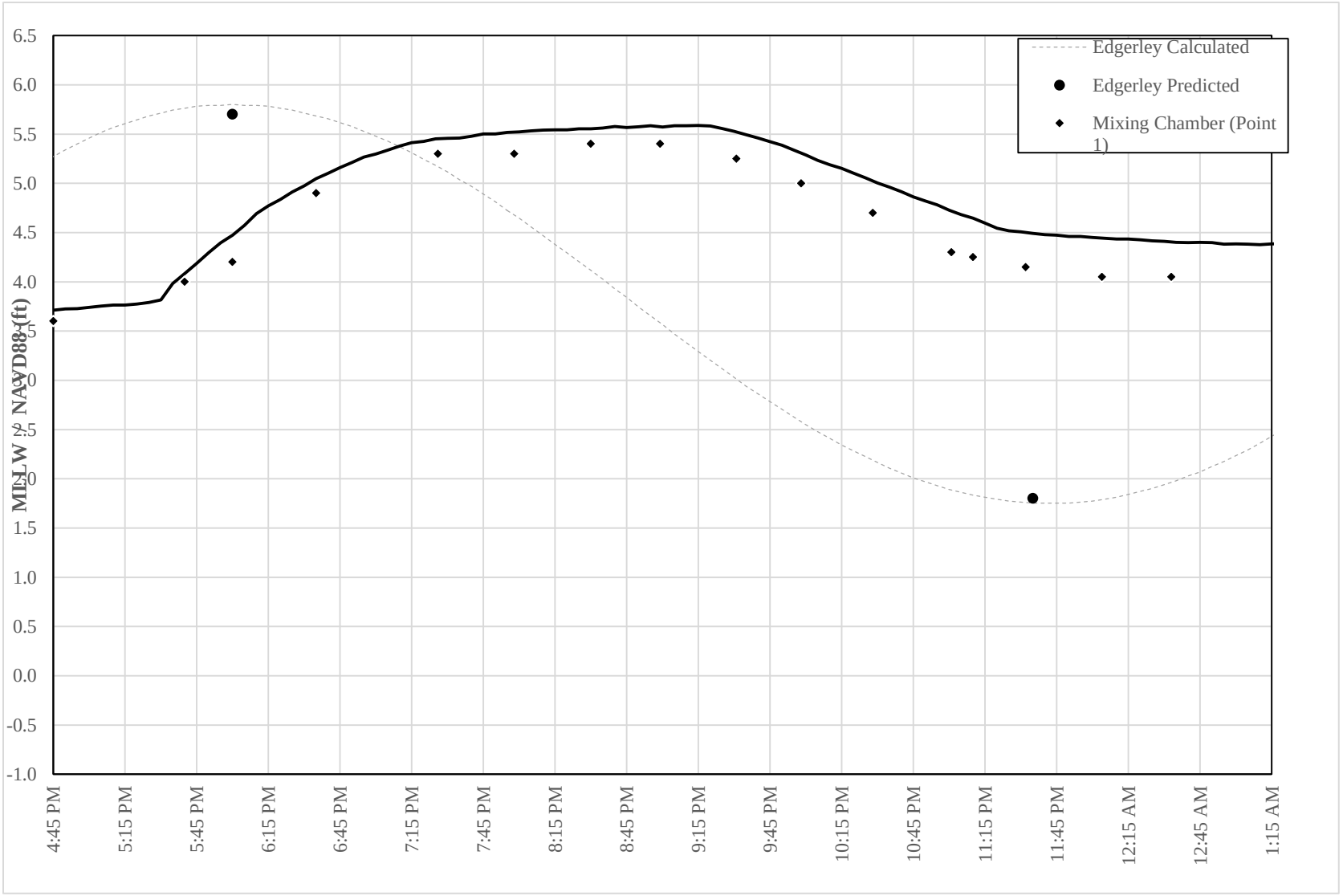

Circular Weir


Sunrise, August 22, 2017

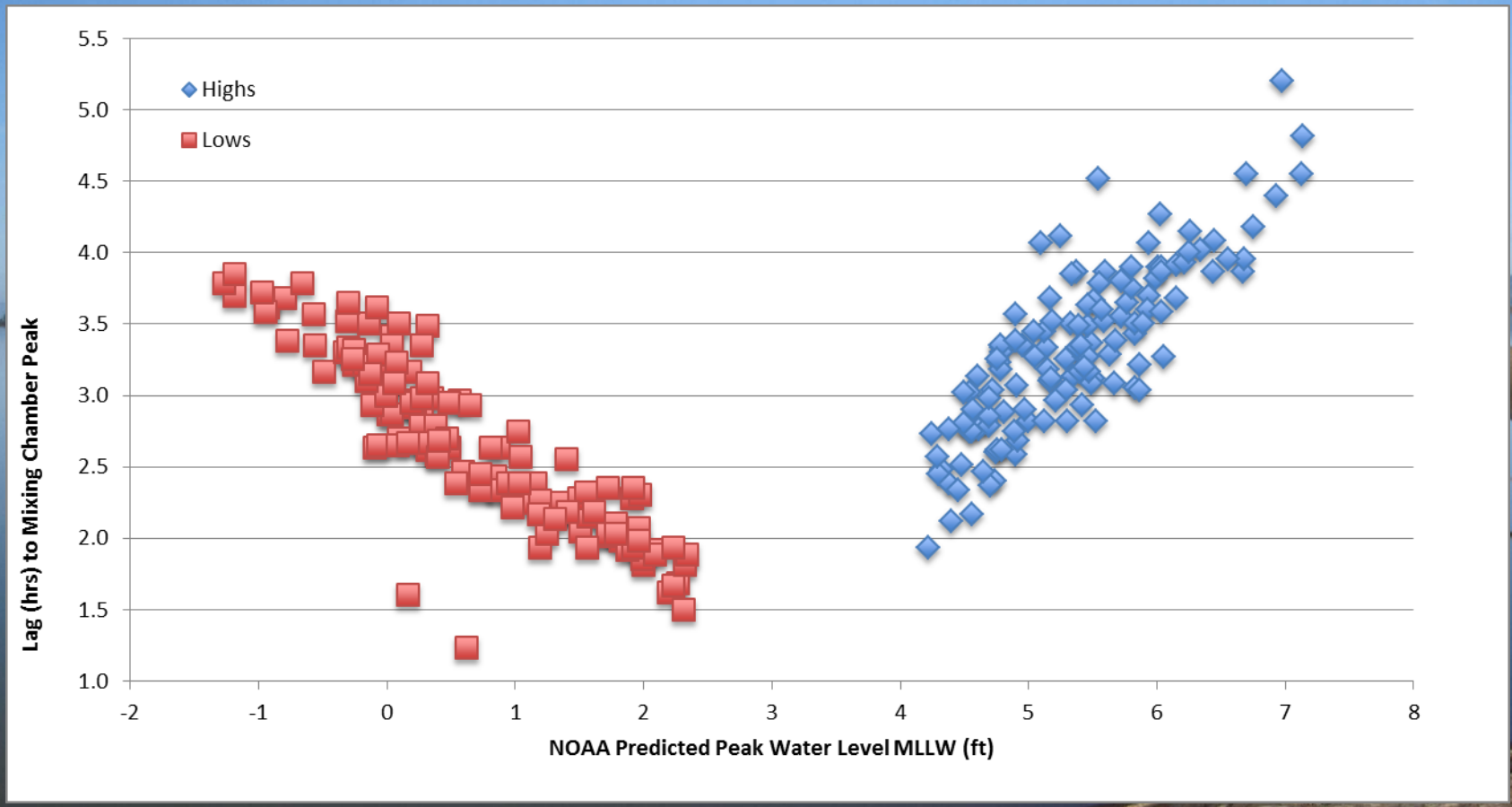
QUESTION 1 FINDINGS

- There is a substantial lag between the nominal high/low tides, and start and stop of flow from the mixing chamber
- With continuous flow from Pond 7, high salinity brine accumulates when there is no flow from the mixing chamber
- Significant stratification occurs when flow restarts
- Complete mixing is achieved without the bubbler by the time discharge reaches Napa Slough Outlet
- Mixing occurs across the weir, through the mixing chamber outlet, and in the Pond 7 Canal
- The mixing chamber is containing the high salinity brine during periods of no flow from the mixing chamber
- Limiting the bittern-related salinity increase to 3 ppt is physically impossible for a continuous flow scenario (Pond 7 8-inch gate would be open less than 1 inch)
- Bittern salinity increases above 3 ppt are of limited duration and frequency

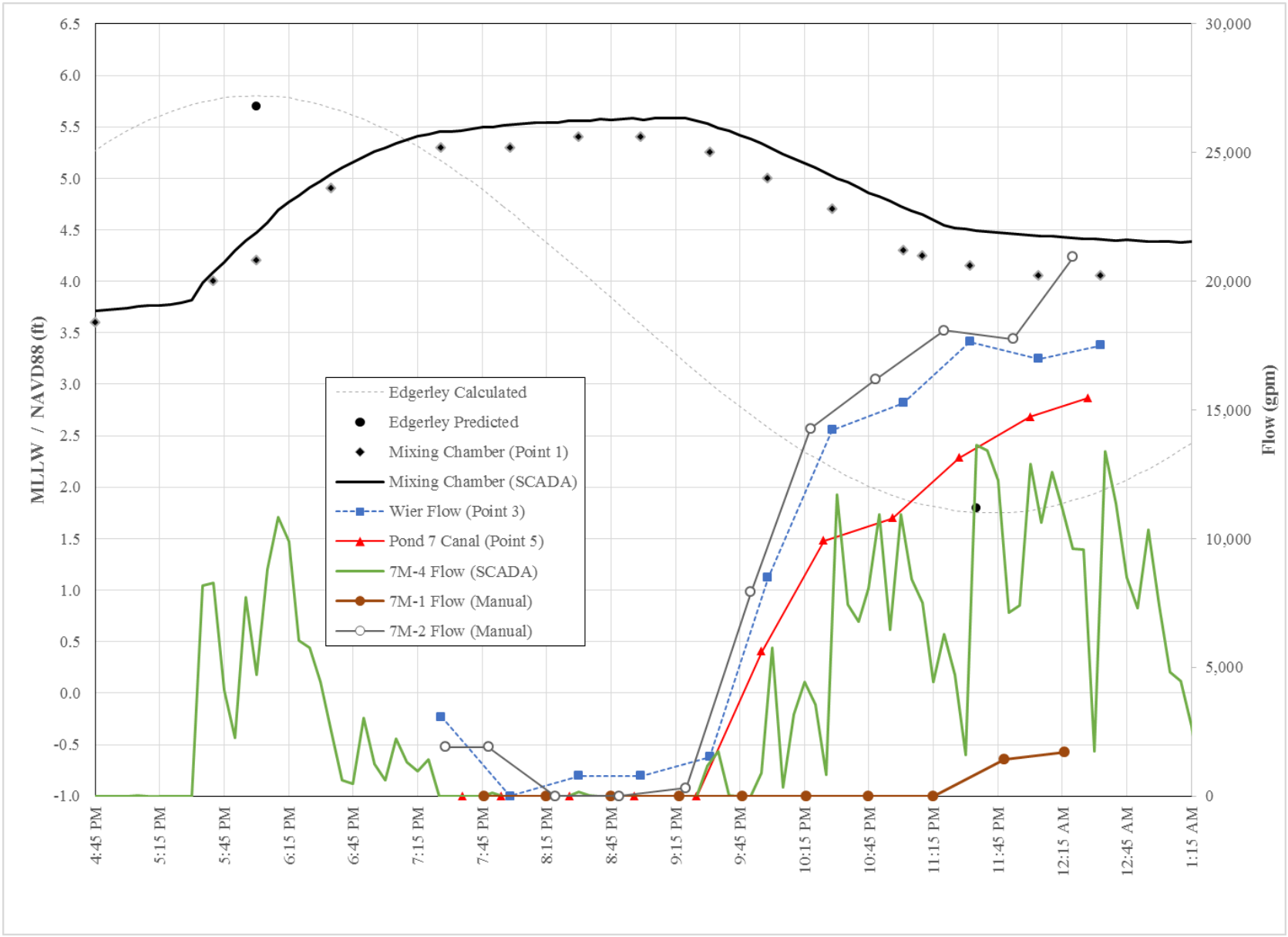
LAG IN MIXING CHAMBER WATER LEVELS RELATIVE TO HIGH TIDE



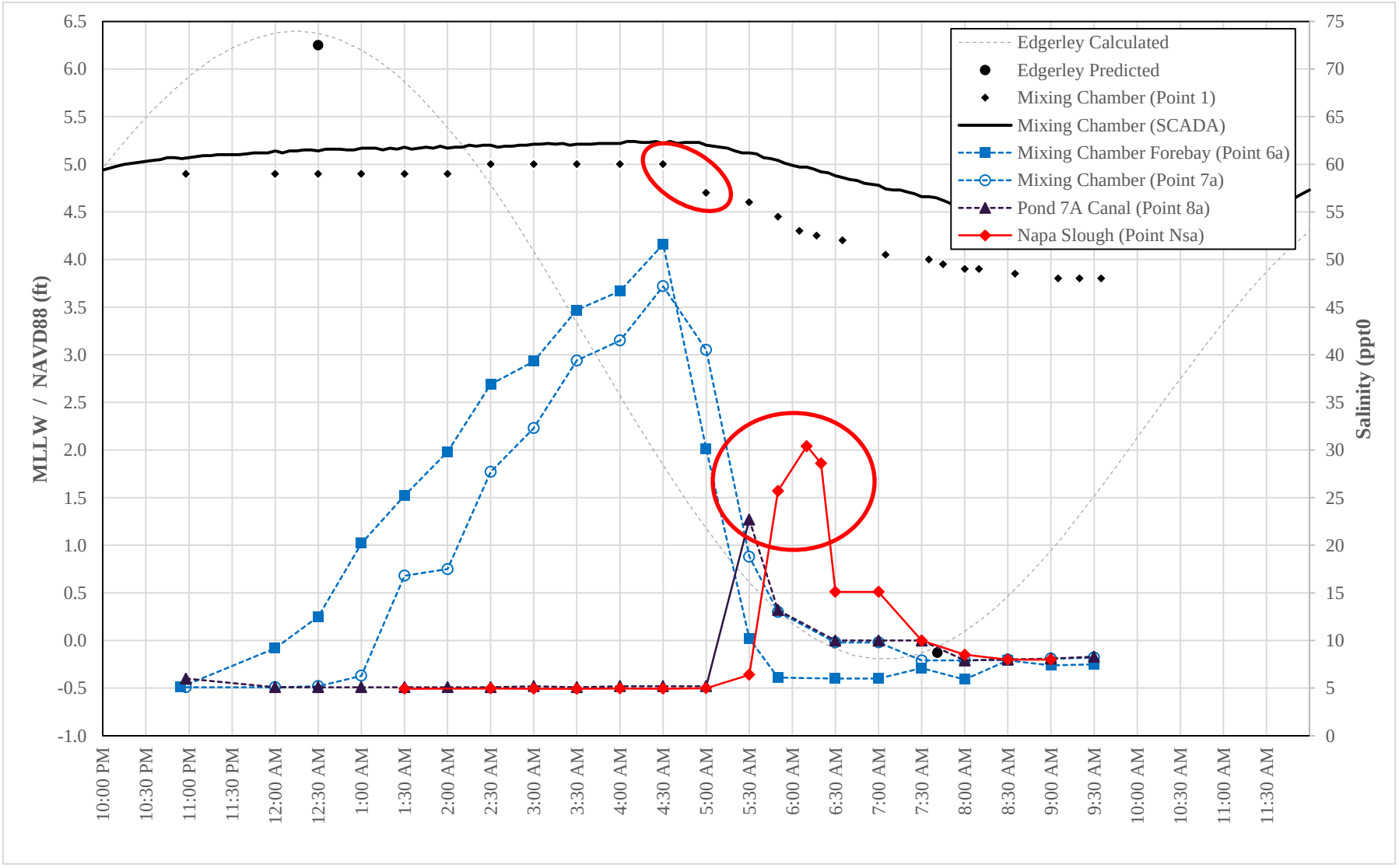
LAG IN MIXING CHAMBER WATER LEVELS RELATIVE TO HIGH TIDE



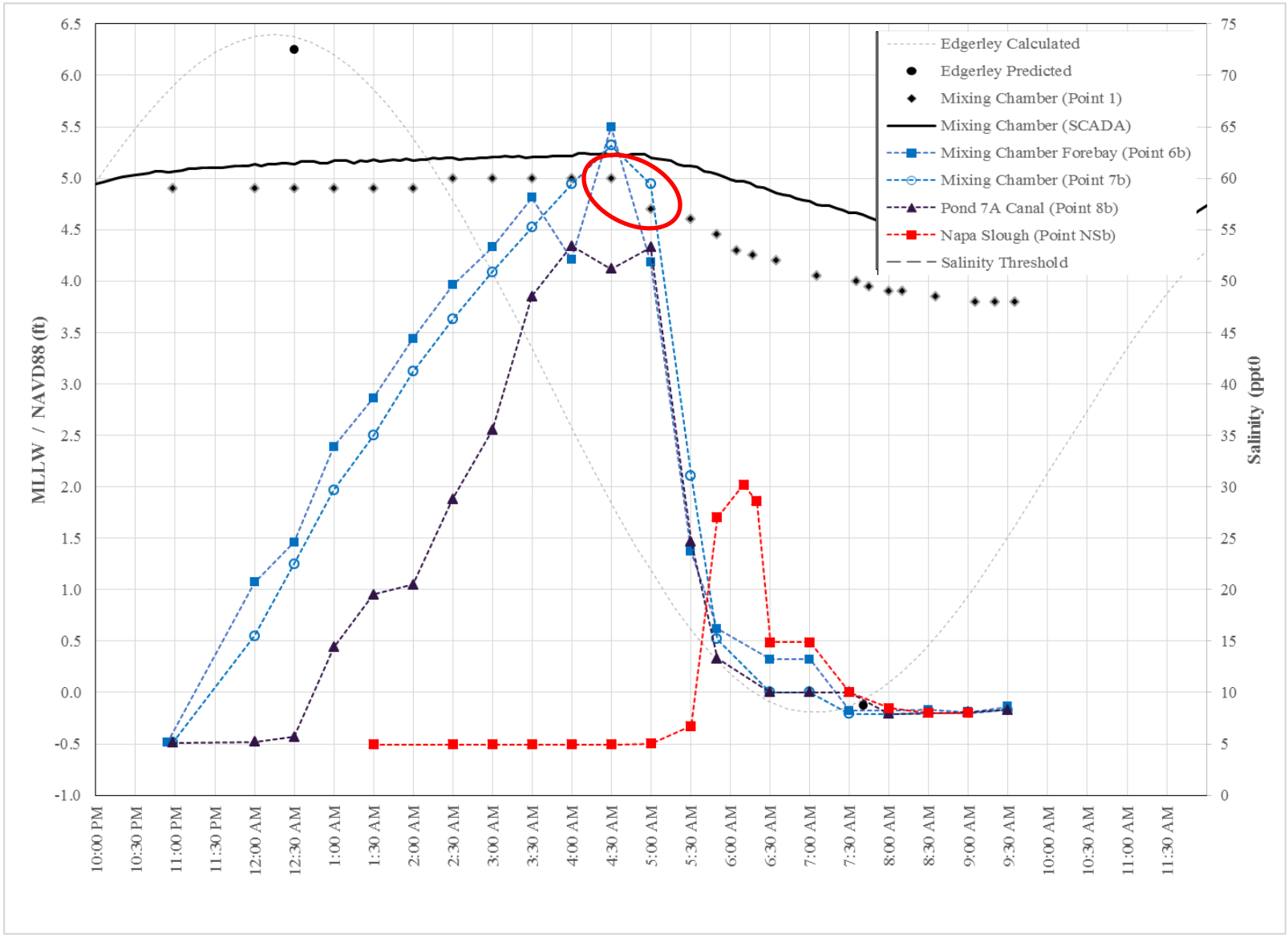
POND AND MIXING CHAMBER FLOWS RELATIVE TO TIDE STAGE

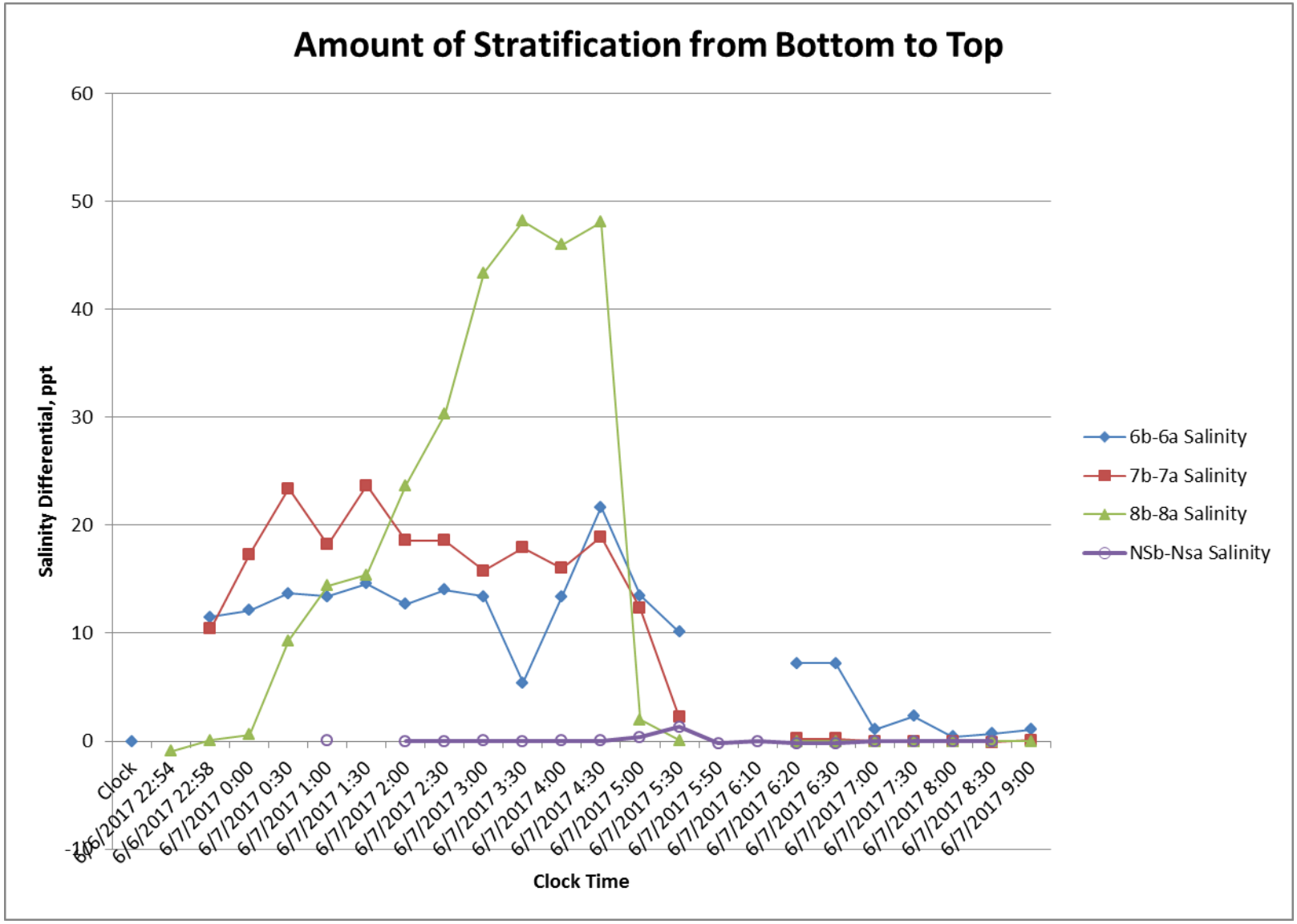


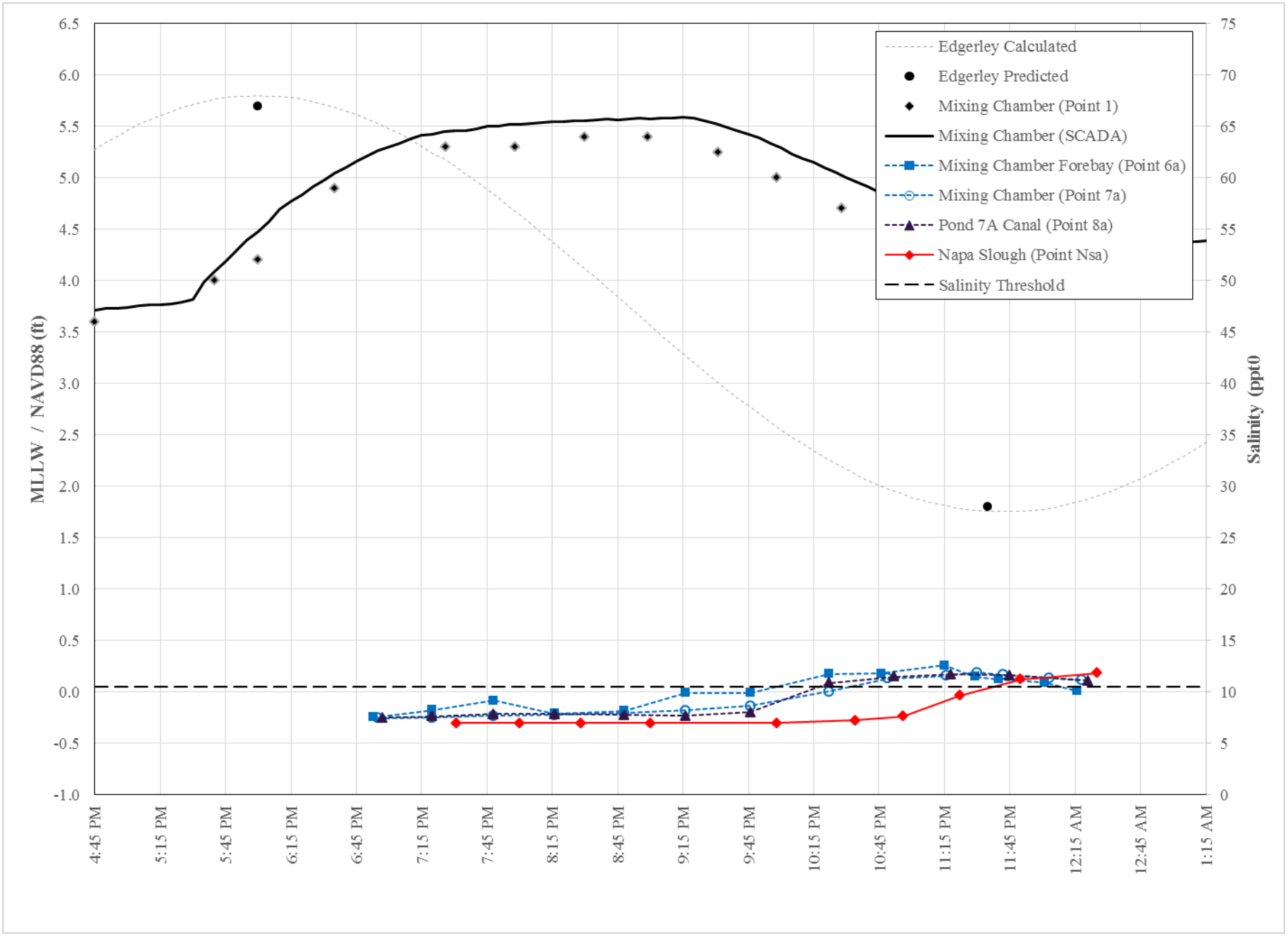
SALINITY RESPONSE TO MIXING CHAMBER FLOW – NEAR BOTTOM



SALINITY RESPONSE TO MIXING CHAMBER FLOW – NEAR BOTTOM




Amount of Stratification from Bottom to Top
Salinity Differential, ppt
60
50
40
30
20
10
0
-10
Clock
6/6/2017 22:54
6/6/2017 22:58
6/7/2017 0:00
6/7/2017 0:30
6/7/2017 1:00
6/7/2017 1:30
6/7/2017 2:00
6/7/2017 2:30
6/7/2017 3:00
6/7/2017 3:30
6/7/2017 4:00
6/7/2017 4:30
6/7/2017 5:00
6/7/2017 5:30
6/7/2017 5:50
6/7/2017 6:10
6/7/2017 6:20
6/7/2017 6:30
6/7/2017 7:00
6/7/2017 7:30
6/7/2017 8:00
6/7/2017 8:30
6/7/2017 9:00
Clock Time
6b-6a Salinity
7b-7a Salinity
8b-8a Salinity
NSb-Nsa Salinity


Edgerley Calculated
Edgerley Predicted
Mixing Chamber (Point 1)
Mixing Chamber (SCADA)
Mixing Chamber Forebay (Point 6a)
Mixing Chamber (Point 7a)
Pond 7A Canal (Point 8a)
Napa Slough (Point Nsa)
Salinity Threshold
MLLW / NAVD88 (ft)
Salinity (ppt0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
4:45 PM
5:15 PM
5:45 PM
6:15 PM
6:45 PM
7:15 PM
7:45 PM
8:15 PM
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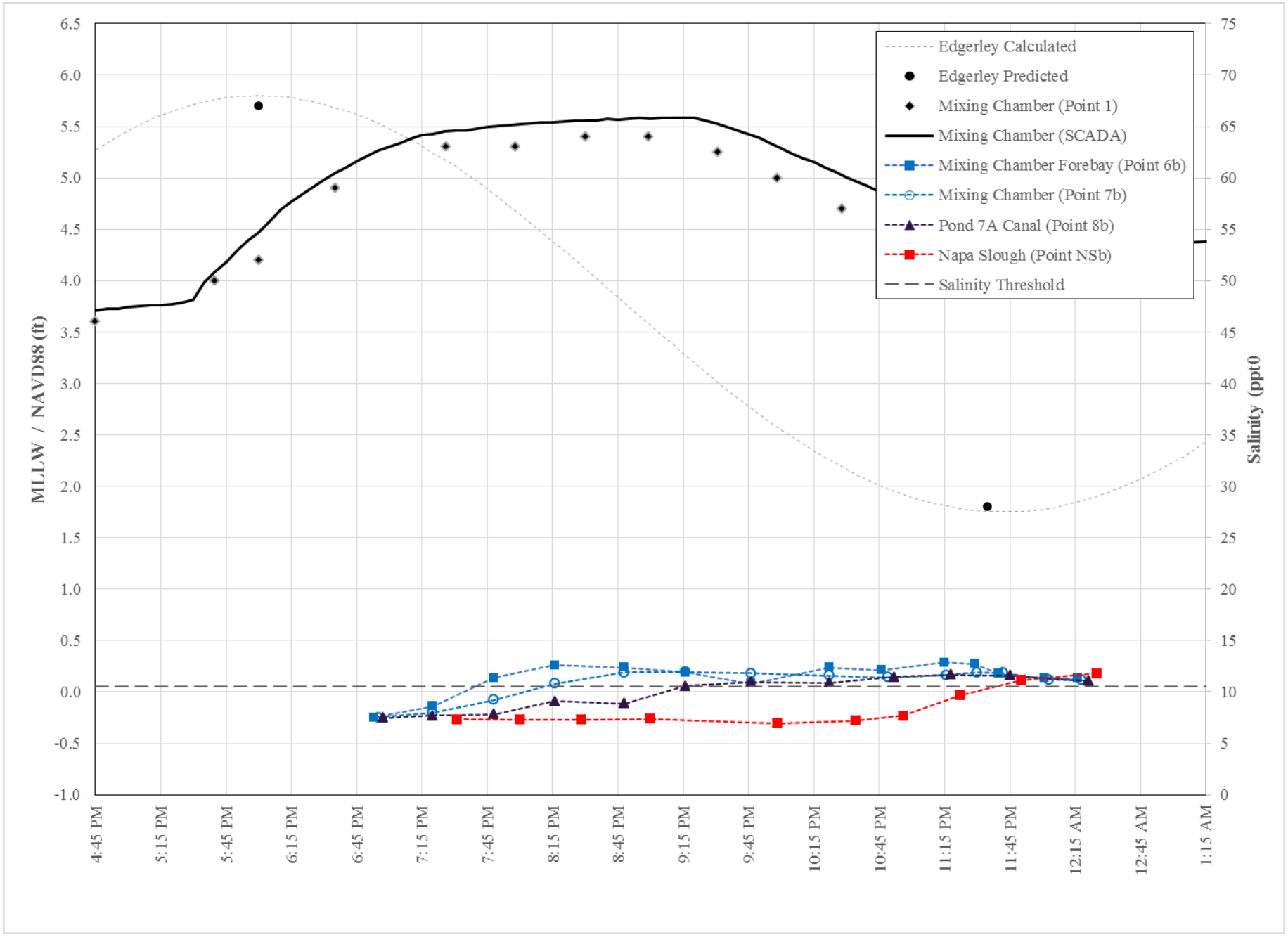
11:45 PM
12:15 AM
12:45 AM
1:15 AM


Edgerley Calculated
Edgerley Predicted
Mixing Chamber (Point 1)
Mixing Chamber (SCADA)
Mixing Chamber Forebay (Point 6b)
Mixing Chamber (Point 7b)
Pond 7A Canal (Point 8b)
Napa Slough (Point NSb)
Salinity Threshold
MLLW / NAVD88 (ft)
Salinity (ppt0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
75
70
65
60
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5:15 PM
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7:15 PM
7:45 PM
8:15 PM
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9:45 PM
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10:45 PM
11:15 PM
11:45 PM
12:15 AM
12:45 AM
1:15 AM

STATUS OF SALINITY TESTING

- Have conducted dry season monitoring with continuous flow during different tide stages
  - Even at smallest physically-maintainable gate opening (15%, ~1 inch), maximum salinity at Napa Slough outlet periodically exceeds salinity threshold
  - When the gate is open 15%, sediment accumulates and blocks the flow, typically within 3 – 5 days (even with a sediment control weir); sediment must be cleaned out manually or can be flushed out by opening the gate all the way for an hour or so.
  - Data being reviewed/processed

2017 MONITORING AND TESTING

- **Question 2**: Monitored mixing chamber at slack high tide with maximum recycled water flow
  - Monitor change in water level in mixing chamber
  - Assess mixing chamber response to recycled water flow
- Result: due to high “reservoir” capacity in Pond 7 Canal, max recycled water flow only increased water level in mixing chamber 2 inches

NEXT STEPS

- Address remaining questions
  - How much higher must the water level be in Pond 7A relative to Pond 7 to stop flow from Pond 7 at slack high tide?
  - How does the Mixing Chamber behave with higher (winter) pond water levels?
  - How often/long, on average, would salinity thresholds be exceeded during continuous flow operation?
  - What would be the risk associated with the periodic exceedances?

NEXT STEPS

- Refine/revise Mixing Chamber operating process
  - Gate opening
  - Adjusting for decreased bittern concentration
  - Sediment control
- Estimate amount of bittern removed to date by calendar year and adjust bittern discharge rate
- Request permit modification (administrative change)


QUESTIONS?